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by

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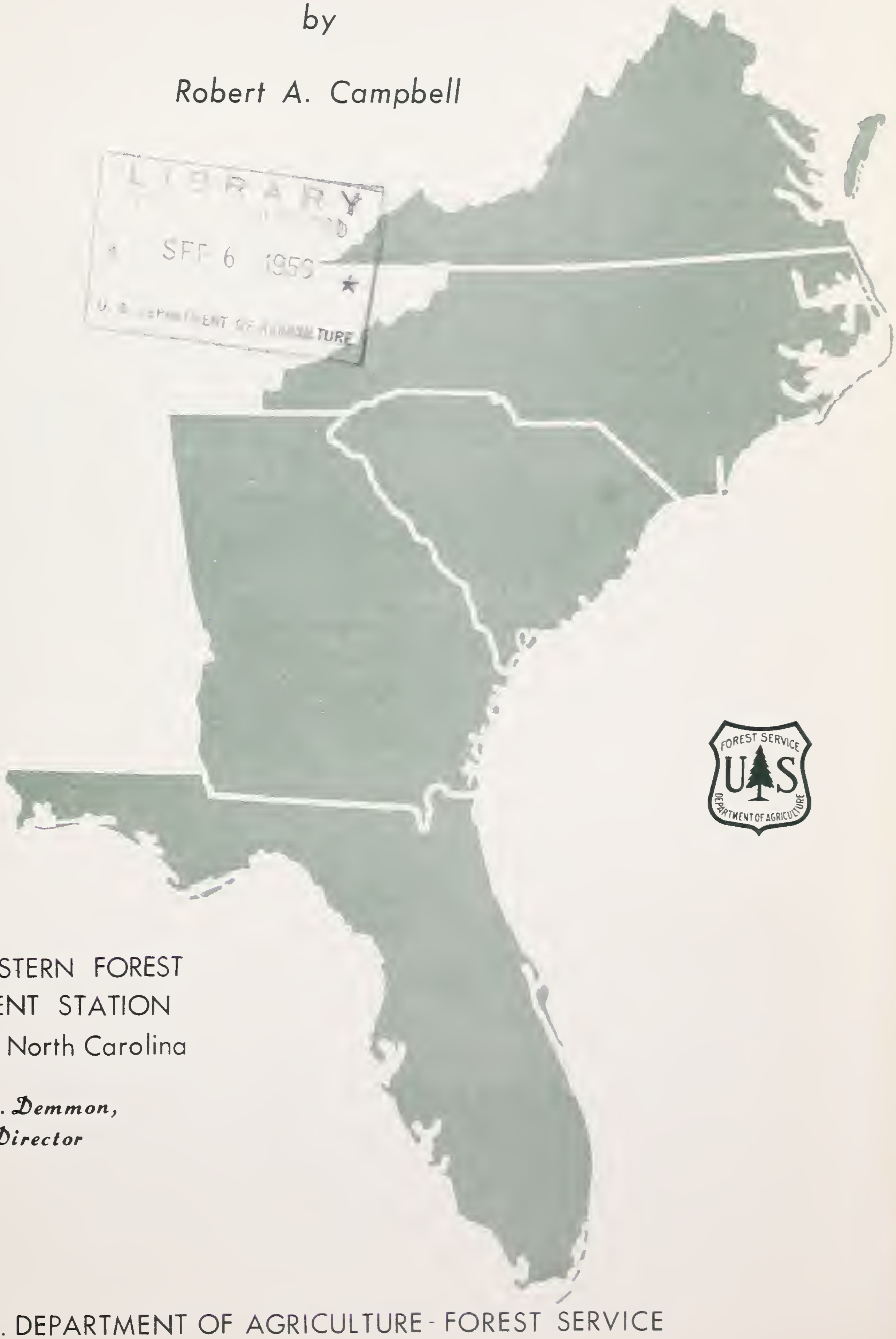

SOUTHEASTERN FOREST
EXPERIMENT STATION
Asheville, North Carolina

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U. S. DEPARTMENT OF AGRICULTURE - FOREST SERVICE

PROFITS FROM PRUNING APPALACHIAN WHITE PINE

by
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INTRODUCTION

Although the acreage of white pine in the Southern Appalachians is relatively small compared with the area of other forest types, this species is important to the forest economy of the region because of the high unit value of the product and large potential returns per acre. Of the 3½ million acres of white pine from Maryland southward, four-fifths were estimated to be immature or below sawtimber size, according to the unpublished "Report on White Pine Blister Rust Control for the Southern Appalachian Region," issued in 1951 by the Bureau of Entomology and Plant Quarantine, USDA. Thus, the possible returns from pruning young white pine stands are very large.

Studies made by Ball (2) indicate that the acreage of white pine is increasing in the region. A high proportion of these stands are now or soon will be of a size suitable for pruning. Furthermore, white pine is being planted at the rate of over 5 million seedlings per year (1). Assuming an average of one thousand seedlings per acre, this means another 5 thousand acres of white pine yearly, in addition to the areas seeding in naturally.

Of all eastern conifers white pine has the most persistent limbs, and is most in need of pruning if clear lumber is to be produced under management. But information on pruning white pine in the Appalachians is very fragmentary, and no previous analysis of its profitability is available.

This publication summarizes results of a 19-year test of healing time and growth rate of white pines after pruning, and analyzes the profitability of the pruning operation. Specific purposes of the study were:

(1) to determine average healing time for various size knots.

(2) to determine average diameter growth of pruned trees per decade.

(3) to incorporate the results of the above findings into a study of the profitability of pruning white pine in this region

LITERATURE REVIEW

Most of the past research on pruning eastern white pine has been done in New England, where white pine has been a mainstay of local industry since colonial times.

An early report by Cline and Fletcher (6) in 1928 covered the number and kind of trees to prune, height of pruning, tools to use, cost of pruning, and the expected profit. They found pruning yielded a profit of at least $15 per thousand board-feet. The next comprehensive study was made in the same general area by Hawley and Clapp (9). They recommended specific pruning practices, and gave detailed costs for these. Mollenhauer (13), in 1938, conducted a very complete time-cost study of pruning planted white pine in Maryland. He tested several methods and more than 20 tools, and gave detailed time results and comparisons. In 1940, Jensen and others (12) analyzed the increase in white pine timber values due to pruning. Barrett and Downs (3) reported in 1943 on the growth response of white pine to green pruning in the Southern Appalachians. Their study was based on the same trees used in this report.

Since 1950 most of the white pine pruning literature has to do with results in the West on *Pinus monticola* (Huey, 11). A comprehensive recent publication by J. H. G. Smith (16) deals with profits from pruning Douglas-fir and ponderosa pine, but is generally applicable to white pine and other conifers. He presented a general method for determining the diameter growth at breast height that would result in various clear-shell thicknesses in pruned trees. His method was used in the present study.

Pruning cost tends to be directly proportional to limb size (6) and to tree diameter (4, 8, 15, 16). Including an additional half log above the butt log nearly doubled the pruning cost in longleaf pine (8). In slash pine pruning, the upper 9 feet cost more than 3 times as much as pruning the first 8 feet (5). Some pruning rates reported earlier were 95 and 85 linear feet per hour for New England white pine (6, 9), and 144 feet for planted white pine in Maryland pruned by the Tarzan, or climbing, method (13).

Stand density is not an important factor in pruning cost, in planted white pine (13), or in longleaf pine (8), but it is very important to pruning profits through its effect on growth rate.

White pines should be pruned when potential crop trees can be picked and pruned safely in one or two operations without removing over one-third of the live crown. Pruning should be done when the trees reach 4 to 5 inches in diameter as recommended by Barrett and Downs (3), in their earlier report of this study. Helmers (10) came to the same conclusion regarding crown lengths in pruning western white pine. Dahms (7) recommended the same limits of pruning; that is, not over one-third the live crown for ponderosa pine.

THE STUDY

The current study, conducted on the Toccoa Experimental Forest in Union County, North Georgia, was a follow-up of the white pine pruning study begun by Barrett and Renshaw in 1936 and reported by Barrett and Downs in 1943 (3).

The study area is a 5-acre natural stand of white pine located on a south-facing slope along Mulky Creek. The soil is a well drained sandy loam, and the area can be classed as a good site in general, despite some small local variations. Height measurements of the 37-year-old trees indicate a site index of approximately 100 feet at age 50.

At the time of pruning, early in May of 1936, the stand was about 20 years old. All the pruned trees were liberated from competing trees at that time, but many of the smaller trees have become suppressed since pruning. Proper thinnings would have prevented this. The sectioned trees averaged form class 80.

Procedure

In the original study, several different pruning tools were used, including axes, saws, and the Rich mace axe. A hand saw was used in pruning all trees to a height of 8 feet. Other tools were used on trees pruned from 8 to 14 feet, and saws again above 14 feet to a variable upper limit which did not exceed 22 feet. Because of the superior job done with a saw, only trees so pruned were included in the current study. Therefore, sample trees were selected from the trees pruned to 8 feet and those over 14 feet; 24 of these trees (approximately half) were chosen for this study. The other half were left for a subsequent grade-yield study at the time of harvest--some 20 years hence.

Total height and diameter at breast height were determined for each tree before felling. After felling in December 1954, the trees were cross-sectioned at the stump, middle, and top of the pruned log. Healing time for knots of various diameters at the stump, middle, and top of the log was observed on the cross sections cut at these intervals with a power saw. The sections were smoothed on a planer to improve the ease and accuracy of measurements of growth and healing time. Longitudinal sections were also made, as shown in figure 1, to check on healing time and alignment of grain of the pruned log.

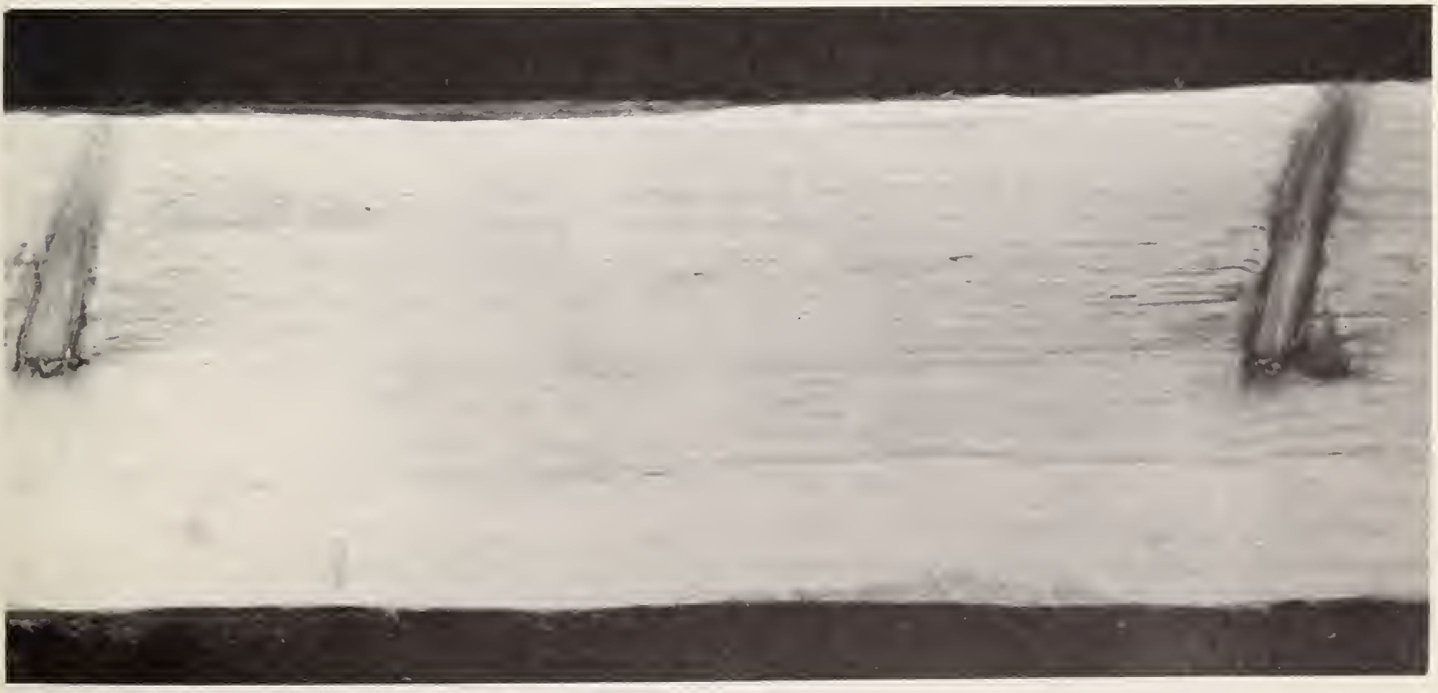


Figure 1.--Quartered section of pruned white pine log 19 years after pruning, showing grain alignment and about 3 inches of clear shell.

Regression analyses were made of the following relationships: (1) healing time compared with knot size, and (2) d.b.h. at time of pruning compared with d.b.h. 8, 11, and 19 years later.

Results

Healing time is significantly related to knot size and to growth rate. The nature of this relationship is shown in figure 2. In this study the average ½-inch knot healed over completely in 3 years, but the average 1-inch knot required nearly 5 years.

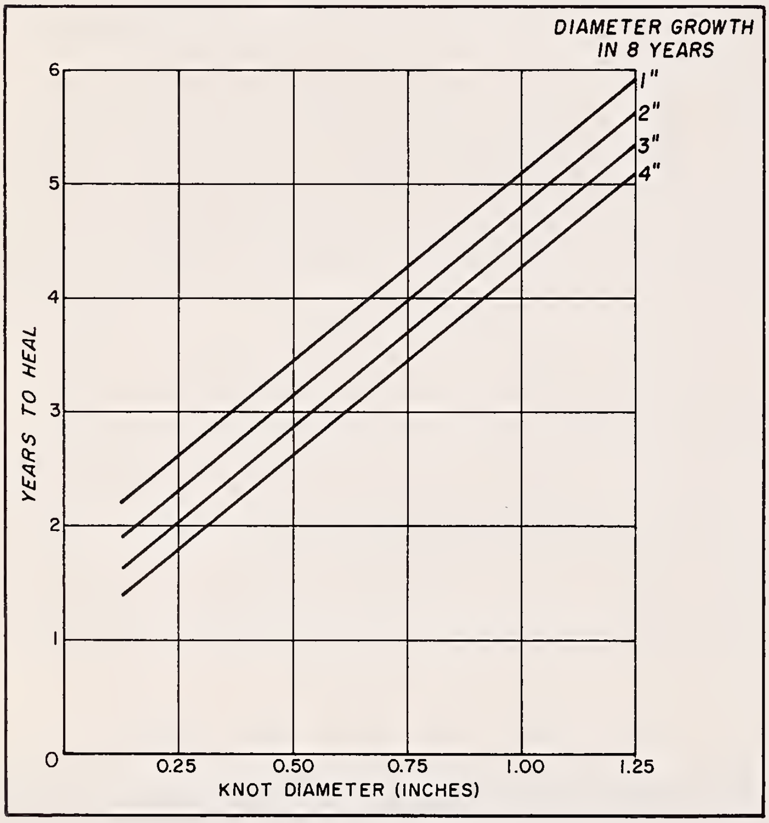


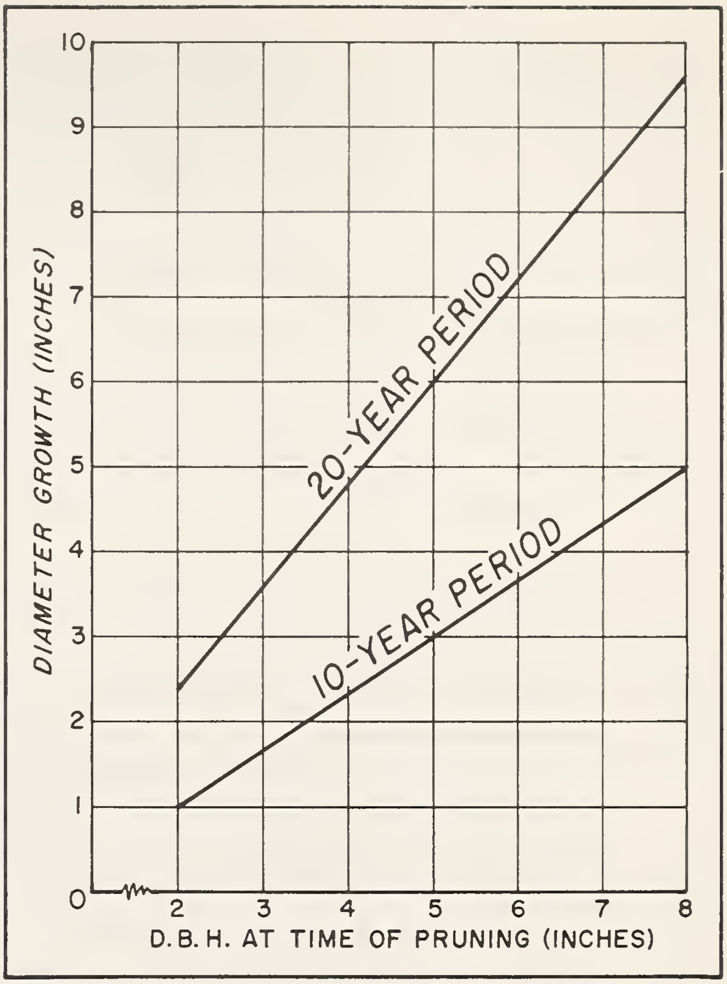
Figure 2.--Relation of healing time in years to knot diameter at time of pruning and to subsequent 8-year diameter growth (based on regression analysis of 52 knots).

Diameter growth in relation to time since pruning is illustrated in figure 3. A good growth rate is imperative in showing a pruning profit. As shown in figure 3, the larger trees pruned in 1936 grew very rapidly in the ensuing 19 years (more than 8 inches in diameter), even though they were thinned only when pruned in 1936. The differences in growth rate shown in figure 3 emphasize the need for picking the most likely crop trees for pruning. Crop trees cannot be selected properly until trees reach 4 or 5 inches in diameter (3). Periodic thinnings are also needed in order to maintain a good growth rate on the pruned trees.

PRUNING COSTS

Pruning costs, in general, are directly related to the number of trees pruned per acre and the size of the tree when pruned. Other related factors to be considered are pruning tools and methods, season of year, stand density, percent of live crown removed, and number and size of limbs. In the Toccoa

Figure 3.--Diameter growth of pruned white pine in relation to diameter at time of pruning (based on regression of 24 pruned trees).



study, pruning time was not recorded in detail, but it was found that an average of 10 trees were pruned per man-hour. At an average height of 10 feet this would amount to 100 linear feet per hour, which compares closely with the average of 95 linear feet given by Cline and Fletcher (6).

Paul's studies (14) indicate that pruning time and costs for white pine are comparable to those for shortleaf pine, since knot size, number and limb retention time are similar. Because of these similarities and in the absence of local white pine cost data it was decided to use Bent Creek[1] pruning costs for shortleaf pine, namely 7 to 11 cents per tree, depending on size and limbiness. These costs are for labor only at 75 cents per hour. When these costs are converted to 85-cent wages plus 25 cents for travel and overhead as above, the total cost per tree is 10 to 16 cents for trees from 4 to 7 inches in diameter, or $10 to $16 per acre for 100 pruned trees.

PRUNING PROFITS

Profits from pruning vary according to (1) cost of pruning, (2) value of clear vs. knotty lumber, and (3) thickness of clear shell or proportion of clear lumber and the time required to grow it.

An important consideration in the profitability of pruned white pine is the high value of knotty white pine for paneling. Not all knotty pine, however, has a high value for this purpose; the lower limbs, which may persist for a long time after they die, result in loose, black knots unfit for paneling. The best paneling in unpruned stands comes from the upper logs containing solid knots from green limbs. To make a profit from pruning, preliminary cost calculations indicate the need for a spread in value between clear and knotty lumber of at least 50 percent in favor of the clear, according to Cline (6) and Jensen (12). Hawley (9) and Smith (16) assigned twice as much value to clear lumber as to the highest knotty grade.

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[1] Bent Creek is the experimental forest of the Southern Appalachian Research Center, located near Asheville, N. C.

In the preliminary calculations leading up to this report, clear lumber values from 50 to 100 percent over those for knotty lumber were used. The purpose of the sliding scale was to allow for the premium given for wider and thicker boards which can be cut only from the larger logs and trees.

Tables 1 and 2 show the costs and expected returns from pruning trees of various sizes. Growth rates for past and future periods shown in table 1 are based on the study average of 3 inches diameter growth at breast height every 10 years. This is a conservative rate for well managed stands on good sites. Extra diameter growth to allow for knot-healing time, for bark thickness, and for taper have been included in the diameter figures of line 2, table 1. The data have been computed for pruning trees 4, 5, and 6 inches in diameter, and for an average harvest age of 70 years. Actually, the pruned trees would be removed in different types of cuttings at different times in a managed stand. Costs have been compounded at a 4-percent rate of interest. Values shown per thousand board-feet are for pruned butt logs only, and are harvest values less compounded pruning costs. Stumpage values per thousand board-feet would probably be from one-fourth to one-third of the lumber value shown in table 2. Hence the landowner or timber grower cannot expect to recover more than a third to a half of the profits indicated in table 2 unless he logs, mills, and sells the lumber as well as raises it.

As shown in table 2, harvest-time profits per tree range from $11.38 to $13.27, depending on tree size at the time of pruning. Profits range from $57 to $63 per thousand board-feet for pruned butt logs at time of harvest, and per-acre profits average close to $700. Profits per acre are not greatly affected by pruned tree size in this study when growth rate and shell thickness are kept constant.

A 6-inch clear shell was selected as the basis for tables 1 and 2 because this clear shell thickness gives optimum annual return. Profits from a 5-inch clear shell would be less, and from a 7-inch shell more. These profits are shown as percentages in the following comparison:

Pruning diameter	5-inch clear shell	6-inch clear shell	7-inch clear shell
	(Percent)	(Percent)	(Percent)
4 in.	60	100	110
5 in.	55	100	120
6 in.	50	100	130

Table 1.--Growth and volume of white pine pruned at 4-, 5-, and 6-inch diameters and held for 53, 54, and 55 years, respectively--time needed to grow a 6-inch clear shell

Pruned tree d.b.h. (inches)	D.b.h. growth o.b. needed for 6-inch clear shell [1]	Total d.b.h. at time of harvest	Average 10-year d.b.h. growth assigned	Butt log d.i.b. at harvest [2]	Butt log volume, clear [3]	Butt log volume, knotty
	Inches				Board feet	
4	16.0	20.0	3.0	16.0	165	15
5	16.3	21.3	3.0	17.0	180	25
6	16.5	22.5	3.0	18.0	200	30

[1] The 6-inch clear shell is measured at top of butt log. To produce this, the diameter at breast height must be more than double clear-shell thickness. Explanations regarding this allowance for taper and slab are given by Smith (16).

[2] Using i.b. form class of .80 for total d.b.h. at time of harvest.

[3] From figure 2, Smith (16).

Table 2.--Pruning costs and harvest values for white pine pruned at 4-, 5-, and 6-inch diameters and held for 53, 54, and 55 years, respectively--time needed to grow 6-inch clear shell
(In dollars)

Pruned tree d.b.h. (inches)	Cost			Value		Profit at harvest		
	Initial pruning	Pruning plus 20% mortality [1]	Pruning and mortality compounded at 4%	Pruned log [2]	Unpruned logs [2] [3]	Per tree	Per M bd. ft. [4]	Per Acre [5]
4	.10	.12	1.00	30.38	18.00	11.38	63.00	683.00
5	.13	.16	1.33	34.00	20.50	12.17	59.40	670.00
6	.16	.20	1.73	38.00	23.00	13.27	57.00	664.00

[1] Initial cost of pruning divided by 0.80.

[2] Values based on prices of $100 per M bd. ft. for knotty lumber and $175 for clear lumber.

[3] Assuming no clear lumber.

[4] Based on 5.5, 5.0, and 4.3 pruned butt logs, respectively, per M bd. ft.

[5] Harvesting 60, 55, and 50 trees, respectively, per acre.

CONCLUSIONS

The pruning of white pine promises to be a very worthwhile investment in the Southern Appalachians if confined to the better sites, if done early and properly, and if followed by light but frequent thinnings.

Pruning should be done only on the better sites, where the fast growth rate will offset the compounding of costs. Trees should be pruned when they are from 4 to 6 inches in diameter. Not over one-third the live crown should be removed in any operation.

Systematic thinnings starting at age 20 or at the time of the first pruning should be repeated every 5 years to age 40 and every 10 years thereafter to keep the growth rate of the pruned trees up to maximum and to prevent loss through mortality. Such a program should result in a profit of $700 or more per acre over and above the cost of pruning and thinning.

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